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(54) **A MOTOR ENERGIZING CIRCUIT.**

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Description

The present invention relates to an energizing system for a reluctance motor of the kind disclosed in the preamble of Claim 1.

The most usual manner of controlling commutation from one phase to another in reluctance motors, particularly so-called switched-type drive motors is to use at least one rotor sensor which is adapted to produce control signals that correspond to the rotational position of the rotor in relation to the stator, below called rotor position. This means, however, that an additional element must be mounted on the rotor, which in practice has been found to encumber a number of drawbacks and to give rise to errors, particularly in troublesome environments.

Brushless d.c. motors which operate with variable reluctance are well known to the art. The type of reluctance motor for which the invention is intended comprises a stator on which one or more excitation windings are arranged in one or more phases, with separate energizing or activation of the winding belonging to the respective phases. Both the stator and the rotor are normally provided with poles or teeth. The rotor has no winding. The stator and the rotor form a magnetic circuit for generating a mechanical torque which is substantially proportional to the square of the ampere-turn (magnetomotive force) of the excited or activated winding and to the permeance change time, which is a function of the movement of the rotor in the motor. Movement of the rotor relative to the stator generates a variation in the reluctance and therewith the permeance in the magnetic circuit of the stator winding.

Torque is only obtained in the drive direction of the motor when the magnetomotive force of the winding is maintained for a rotor position period in which the permeance increases with rotor movement. Consequently, it is desirable to hold each winding energized solely during one such period for this winding. For reasons pertaining to drive techniques it is convenient although not fully necessary, to energize or activate solely one stator phase at a time, i.e. with no overlap between the phase energizations. Commutation from one phase to another can be effected so that each phase winding is energized or activated during a rotor position period in which the permeance increases with rotor position changes. The supply to each phase winding should be discontinued, or decreased, during each rotor position period in which the permeance decreases with rotor position changes. As beforementioned, the most usual method in this regard is to use additional rotor sensors for sensing continuously the position of the rotor and controlling the energizing or power supply with the aid of a sensor-controlled circuit. There is a general desire however, to find ways and means which will allow these rotor position sensors to be dispensed with. Conse-

quently, several attempts have been made to utilize the variation of the current or voltage characteristics of the stator windings and surrounding circuits to provide an indication of suitable points of time at which the supply voltage can be switched on and off.

In one known reluctance motor control system, described in US Patent No. 3,980,933, there is sensed the electro-motive force (EMF) which is induced in the stator winding when the rotor rotates and when the output from a switching device is non-conducting. The output of the switching device is made conductive when the EMF reaches a given level. A considerable bias current is required with this motor, in order to provide sufficiently wide margins. This results in power losses. Furthermore, since no energizing current is delivered to the winding during that time period in which the rotor position is sensed, it is not possible to load the motor to its maximum. Consequently, a driving or energizing current must be applied constantly to one of the phase windings.

In the case of another reluctance motor control system, disclosed in US Patent No. 4,520,302, high frequency voltage pulses are supplied over the phase winding in that phase which is next in turn to be energized. The current rise time or current fall time in the winding is measured in order to provide an indication of the rotor position so as to obtain the correct commutating position. The reluctance motor control system described in this publication functions solely with stepping motors, in which the motor is rotated solely to desired positions of rotation. It will not function with drive motors which are intended to operate under widely varying loads.

The object of the present invention is to provide a reluctance motor control system for use with drive motors. This object is achieved by means of the inventive energizing system having the characteristic features set forth in Claim 1. Further properties of the inventive energizing system are disclosed in the remaining Claims.

The invention will now be described in more detail with reference to the accompanying drawings, in which

Fig. 1 is a circuit diagram which illustrates one embodiment of the control system according to the invention; and

Fig. 2 is a diagram which illustrates the manner of operation of the invention.

The circuit, or system, illustrated in Fig. 1 includes three phase windings L1, L2, L3 arranged on the stator of a three-phase reluctance motor. The invention is not restricted to the number of phases of the motor, and three phases have been shown solely by way of example. The motor is driven by a d.c. voltage +V, which may be 310 V for example, this voltage being a normal voltage for drive-type and switch-type reluctance motors. Between earth and the positive terminal of the voltage source, the phase winding L1

is incorporated in a circuit which comprises a current measuring resistance R1, the source-drain-path of a power transistor Ta1, the phase winding 1, and a power transistor Tb1. In this circuit, the lower transistor Ta1 is biased during the whole time over which the phase winding L1 is to be excited or energized, whereas the upper transistor is pulsed during the phase energizing interval in the manner conventional with switched reluctance motors, where each phase energizing or drive pulse is divided into partial pulses. This division of the energizing pulse into partial pulses does not constitute part of the actual invention and will not therefore be described in detail. The anode of a diode Da1 is connected to earth and the cathode thereof is connected to the part of the phase winding L1 remote from the transistor Ta1, so as to maintain the current through the phase winding L1 during the whole of the energizing pulse interval. A diode Db1 is connected with the anode of the diode connected to the part of the phase winding L1 remote from the transistor Tb1 and the positive terminal, to provide a current circuit in which the phase winding L1 is rapidly drained of current as soon as the transistor Ta1 is switched off, i.e. blocked.

Each of the remaining phase windings L2 and L3 is connected in a similar respective circuit. Thus, the phase winding L2 is incorporated in a circuit which comprises a current measuring resistor R2, two power transistors Ta2 Tb2, and two diodes Da2, Db2, and the phase winding L3 is incorporated in a circuit comprising a current measuring resistor R3, two power transistors Ta3, Tb3 and two diodes Da3, Db3.

Switching of the transistors to their respective on and off modes is controlled by a control unit 1. This unit is preferably a microprocessor or microcomputer, although the unit may also consist of a circuit comprised of conventional circuit components. The control unit 1 has six outputs each of which is connected to the gating means of their respective transistors Ta1, Ta2, Ta3, Tb1, Tb2, Tb3, via a respective amplifier 2, for the purpose of controlling each transistor individually.

The inductance of the phase next in turn to be excited is sensed in order to detect an inductance value relative to a certain position at which commutation shall be effected for energizing of the phase.

Since normally no current flows in an unenergized or non-activated winding, high frequency pulses of short duration are fed from the control unit to the gating means of the power transistors in the energizing circuit of that winding which is next in line for excitation. The control unit 1 will, of course, also steer the power transistor at the same time to an energizing or power phase in a conventional manner. Each pulse has a given duration, T, which is short in relation to the time period, so that the current in the sensed winding has time to fall to zero between each pulse. The current is measured at the end of each pulse by an

analogue/digital converter 3 connected to the control unit 1. The rise in current during the duration of each pulse gives an indication of the inductance in sensed winding that prevails at that time T. Accordingly, each of three inputs of a multiplex unit 5 is connected to a respective one of the resistors R1, R2, R3, all of which have the same resistance. The fourth input of the multiplex unit will be described hereinafter. The multiplex unit 5 is controlled by the control unit 1 with a digital signal for stating which of the inputs of the multiplex unit shall be connected to its output.

In order to measure the current in the pulse phase which lies in turn to become energizing, the control unit 1 instructs the multiplex unit to supply the voltage across the resistor R1, R2, R3 which belong to the phase circuit in turn to be the driving circuit next to the input of the analogue/digital converter 3. In addition hereto the multiplex unit 5 is steered to carry out further functions in a manner hereinafter described.

The control unit 1 determines the inductance by approximating the equation $(U - Ri) = d/d \tau (L \cdot i)$ with $U = L \cdot di/d \tau$, which is a good approximation for small currents i and low speeds, i.e. low $dL/d\tau$.

The US patent No. 4,520,302 mentioned in the introduction describes one such system which measures the time of current changes in a non-energizing phase, which in practice involves measuring the inductance in this phase. Consequently, according to this published patent specification, commutation is effected when the inductance in the phase on which the measurement is carried out has reached a predetermined value.

It is assumed in the known control system that the supply voltage is constant. In practice the supply voltage V can often vary quite widely, due to normal variations in voltage and also to the voltage ripple obtained when +V is a rectified a.c. voltage.

The inductance of a phase is highly dependent on the current in said phase. In present day reluctance motors, parts of the iron circuit are mostly common to the various phases. Saturation, and therewith reduced inductance in a phase (see Fig. 2), consequently results in partial saturation and therewith reduced inductance also in remaining phases.

The current in the winding of an energized phase increases with increasing load which causes the variation of inductance in the winding to decrease with increasing loads. Fig. 2 illustrates the inductance L as a function of the rotational position θ for two different loads the curve A being obtained with a low load i.e. a relatively low value of the current i in the energized phase, and the curve B being obtained at relatively high loads, i.e. a high energizing current. Since the iron circuit is common to the phases, similar variations in inductance in the windings is obtained in all phases irrespective of whether these phases are energized or not.

The inductance in a non-energized phase is also

dependent on the current strength in an energized phase. The control circuit described in US Patent No. 4,520,302 takes no account of inductance variations due to current level, which makes it difficult to drive the motor described in said publication at different loads.

Consequently, in accordance with the invention a compensation is made both for varying supply voltage +V and for varying current in the energized winding. A voltage divider having two series-connected resistors R_x and R_y is connected between the positive terminal at +V on the voltage source and earth. The R_x , R_y outputs of the voltage divider are connected to a fourth input of the multiplex unit 5. The voltage U' measured across R_y is therewith proportional to +V.

With each short pulse to the monitored winding, the control unit 1 will now cause the multiplex unit 5 to transfer the voltage in a selected sequence over the measuring resistor R1, R2 or R3 in a monitored phase, the voltage over the measuring resistor R1, R2 or R3 in an energized phase, and the voltage U' over the resistor R_y to the output of the multiplex unit 5.

The control unit 1 thus indicates the momentary current at the end of each pulse of short duration to the monitored winding in a non-energized phase, by supplying a sample pulse to the control input of the analogue/digital converter 3 at the end of the pulse. In conjunction herewith, i.e. immediately prior or immediately subsequent thereto, the current in the energized phase and the voltage U' are also indicated, by sampling the multiplex unit 5 and the analogue/digital converter 11 at appropriate times. The control unit 1 receives on its inputs connected to the analogue/digital converter 3 signals which are in known proportions to the signals to be measured.

Compensation shall be made for the current in the energized phase and for the momentary supply voltage. This compensation can be effected substantially in two ways. The first is to add a compensating rotor angle which becomes smaller with increasing current in the energized phase. This type of compensation is difficult to effect right down to a stationary motor. The second, and preferred manner is to compensate the indicated inductance.

In order to obtain with this second, preferred method of compensation a rotor position point θ_{OFF} , for interrupting supply to an energized phase and commuting the energization to the next phase, which rotor position point for a selected rotor speed will thus be as constant as possible, the momentary inductance or a value proportional thereto is determined and the inductance value thus obtained compensated.

The function $L_a(\theta, i_b)$, i.e. the inductance in a phase a as a function of the current in a phase b is non-linear with i_b . A good approximation for most types of reluctance motor is

$$L_a(\theta_c, 0)/L_b(\theta_c, i_b) = (1 + c \cdot i_b)$$

where θ_c is the rotor position for which the commu-

tation is to take place, the constant c is determined individually for each motor so as to maintain θ_{OFF} constant. θ_{OFF} is preferably made equal to θ_c . Naturally this is done under the proviso that the inductance is compensated in the aforescribed manner. The commutation condition to be fulfilled when compensating the inductance for both the momentary supply voltage level and the energizing current level is thus

$$L = L_c \rightarrow (1 + c \cdot i_b) \cdot U \cdot T / i_a = L_c$$

L_c is the commutation inductance and i_a is the current level at the time T at the end of the pulse.

This enables a purely static commutation to be achieved irrespective of the current strength in the energized phase and the supply voltage.

Static commutation which is independent of rotor rotation as before described can also be achieved, provided that the rotor speed is low. Firstly it is necessary that the approximation $d/d\tau (L \cdot i) = L \cdot di/d\tau$ applies (i.e. $idL/d\tau \ll L di/d\tau$), and secondly the frequency of the inductance-sensing pulses is higher than the commutating frequency of the motor, since this frequency determines the time resolution in the commutating process.

In practice these limitations merely signify that the motor may be operated to between 20% and 50% of its maximum speed, depending on the construction of the motor, when applying this commutating method. At speeds which lie beneath this limit, however, there is obtained a function which corresponds completely to the function obtained with a rotor position sensor.

From a control aspect, it is simplest to drive each phase individually, with commutation between the phases in the absence of overlap. Naturally, each phase winding may be energized individually in a manner to optionally obtain overlap between the phases, so that two phases are energized simultaneously during given intervals. However, when it is not desired to have an overlap between the phases but to commute at the rotation angle θ_{OFF} from one phase to another, θ_{ON} will be displaced within the rotor angular range in the same manner as θ_{OFF} .

When driving a reluctance motor in accordance with the invention, it may be convenient in the case of extremely low speeds to energize the phase at the beginning of the rising part of the L -curve at θ_{ONL} , but in the case of a higher speed, and particularly when the speed approaches 20% to 50% of the maximum speed, it may be suitable, in order to obtain a good driving effect, to move the rotational position θ_{ON} for phase activation more to the left, i.e. to θ_{ONH} , so that activation is effected on the negative flank of the inductance curve immediately prior to the region of extremely low inductance. This will provide improved and smoother functioning of the motor. Displacement of the activation point θ_{ON} from a location on the rising flank of the inductance curve to a location on the falling flank can be effected continuously. However, it is

difficult to detect inductance differences during the essentially straight part of the curve, i.e. between θ_1 and θ_2 of an induction curve of very low conductance, and consequently it is preferred to move θ_{ON} continuously during the rising and falling parts of the inductance curve and to effect stepwise movement between these locations. The activation point can also be moved stepwise in a multiple of steps. The significance of being able to move this point becomes greater with a decreasing number of phases. This displacement possibility consequently has its greatest significance in motors which comprise two or three phases. In order to obtain this possibility the control unit 1 must calculate the slope of the L-curve, i.e. must compare successively indicated inductance values with one another in order to obtain the sign of the change in inductance.

Consequently, the control unit 1 is suitably provided with a program in which the inductance value and the sign of the inductance change for indicating θ_{ON} are different for different rotational speeds or speed ranges within the low speed range.

Claims

1. An energizing system for a variable reluctance motor comprising:

a stator which is provided with one or more windings (L_1, L_2, L_3) for at least two phases, each of said phases being a driving phase when its winding is energized, a rotor, the rotor position of which influences the permeance in each of said stator windings by cooperation of the rotor with the respective magnet circuit of said windings,

a sensing, calculating and control arrangement (1 to 11) sensing electrical properties of said windings, computing the rotor position using said sensed properties and the times for switching off a driving phase and in a non-driving phase, and controlling the switching on and off of said phase windings (L_1, L_2, L_3) in accordance with the computed times for switching, said sensing, calculating and control arrangement includes means ($R_1, R_2, R_3, 5, 1$) for deriving the inductance in each phase winding, or a magnitude being an approximation of the inductance, during at least that part of a rotational turn of said rotor, when the respective phase winding is next in turn to be in a driving mode;

said sensing, calculating and control arrangement includes means ($R_1, R_2, R_3, 5, 1$) for sensing the current in the winding being in a driving mode;

characterized in

that said sensing and control arrangement includes calculating means (1) which calculates a correction factor for said inductance depending upon the current value in the winding being in a driving mode.

2. An energizing system according to Claim 1,

characterized in that said sensing, calculating and control arrangement corrects the inductance of the winding next in turn to be in a driving mode in accordance with the calculated correction factor, whereby the inductance corresponds with the rotational angle of said rotor irrespective of the current strength in the winding being in the driving mode.

3. An energizing system according to Claim 1 or 2, characterized in that said sensing, calculating and control arrangement includes means (R_x, R_y) for sensing the momentary supply voltage level and means (1) to correct said indicated inductance with a factor which is dependent on the prevailing supply voltage level.

4. An energizing system according to any of the preceding claims, characterized in that said sensing, calculating and control arrangement includes means (1, 2, Ta1, Ta2, Ta3) for supplying voltage pulses of short duration across the phase winding in the phase next in turn to be energized and means ($R_1, R_2, R_3, R_x, R_y, 5, 1$) to measure for each pulse the current level i_a in said phase winding upon termination of the pulse, the duration of said pulse being T, and to measure the current i_b in the phase winding in the energized phase and to measure the drive voltage U' in conjunction with measuring i_a , and to make the following inductance calculation at each measuring moment:

$$L = (1 + c \cdot i_b) \cdot U' \cdot T / i_a$$

where c is a constant contingent on the motor concerned, and to compare the calculated inductance with a reference inductance value L_c , for which commutation shall take place.

5. An energizing system according to Claim 4, characterized in that said reference inductance value L_c is arranged to be changed stepwise.

6. An energizing system according to any of the preceding Claims, characterized in that said sensing, calculating and control arrangement includes means (1) to indicate or calculate rotor speed;

that said sensing, calculating and control arrangement is adapted to calculate a value of the rotational position from this calculation, to which position energizing of the monitored winding next in turn to be driving shall be made;

that said sensing, calculating and control arrangement is adapted to make the calculation of the rotational position in that position, in dependence of the calculated value of the motor speed, represented by a positive or negative flank on an inductance curve on inductance versus rotational position, as calculated by said sensing, calculating and control arrangement, together with notation of prescription for the position of an energizing start time on the flank of the actual inductance curve for the actual speed (FIG. 2).

7. An energizing system according to Claim 6, characterized in that said sensing, calculating and control arrangement is adapted to represent the rotor

position by a positive flank of said inductance curve at a very low motor speed and by a positive flank of said inductance curve at motor speeds which lie relative close to 20 % - 50 % of the maximum motor speed.

Patentansprüche

1. Ein Erregungssystem für einen veränderlichen Reluktanz-Motor umfaßt:

einen Stator, welcher mit einer oder mehreren Windungen (L_1, L_2, L_3) für zumindest zwei Phasen vorgesehen ist, wobei jede der Phasen eine Antriebsphase ist, wenn ihre Windung erregt ist,

einen Läufer, wobei die Läuferposition die Permanenz in jeder der Stator-Windungen durch Zusammenwirken des Läufers mit dem jeweiligen Magnetkreislauf der Windungen beeinflusst,

eine Fühler-, Rechen- und Kontrollanordnung (1 bis 11), die die elektrische Wirkung der Windungen fühlt, die die Rotorposition unter Verwendung der erfüllten Wirkungen und Zeiten zum Ausschalten einer Antriebsphase und in einer Nicht-Antriebsphase berechnet und die das Ein- und Ausschalten der Phasenwindungen (L_1, L_2, L_3) in Übereinstimmung mit den berechneten Schaltzeiten steuert,

daß die Fühler-, Rechen- und Kontrollanordnung Mittel ($R_1, R_2, R_3, 5, 1$) zum Ableiten der Induktivität in jeder Phasenwindung oder einer Größe, die eine Annäherung der Induktivität darstellt, während mindestens eines Teils einer Drehung des Läufers enthält, wenn die jeweilige Phasenwindung als nächste in einen Antriebsmodus kommt;

daß die Fühler-, Rechen- und Kontrollanordnung Mittel ($R_1, R_2, R_3, 5, 1$) zum Abfühlen des Stromes in den Windungen während des Antriebsmodus enthält; dadurch gekennzeichnet,

daß diese Fühler- und Kontrollanordnung Rechenmittel (1) enthält, welche einen Korrekturfaktor für die Induktivität in Abhängigkeit des Stromwertes für die in dem Antriebsmodus befindliche Windung errechnet.

2. Ein Erregungssystem nach Anspruch 1, dadurch gekennzeichnet, daß die Fühler-, Rechen- und Kontrollanordnung die Induktivität für die Windung, die als nächstes in einem Antriebsmodus ist, in Übereinstimmung mit dem errechneten Korrekturfaktor korrigiert, wobei die Induktivität mit dem Drehwinkel des Rotors übereinstimmt, unabhängig von der Stromstärke in der Windung, die in dem Antriebsmodus ist.

3. Ein Erregungssystem gemäß Anspruch 1 oder 2, dadurch gekennzeichnet, daß die Fühler-, Rechen- und Kontrollanordnung Mittel (R_x, R_y) zum Fühlen des momentanen Pegels der Versorgungsspannung und Mittel (1) zum Korrigieren der angezeigten Induktivität mit einem Faktor, welcher von dem herrschenden Pegel der Versorgungsspannung abhängig ist, ent-

hält.

4. Ein Erregungssystem nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß die Fühler-, Rechen- und Kontrollanordnung enthält; Mittel (1, 2, Ta_1, Ta_2, Ta_3) zum Zuführen von Spannungsimpulsen von kurzer Dauer über die Phasenwindung in die Phase, die als nächstes erregt wird und Mittel ($R_1, R_2, R_3, R_x, R_y, 5, 1$) um den Strompegel i_a eines jeden Impulses in der Phasenwindung zum Ende des Impulses zu messen, wobei die Dauer des Impulses T ist und um den Strom i_b in der Phasenwindung in der erregten Phase zu messen und um die Antriebsspannung U' in Verbindung mit der Messung i_a zu messen und um die folgende Induktivitätsrechnung in jedem Meßpunkt durchzuführen:

$$L = (1 + c \cdot i_b) \cdot U' \cdot T / i_a$$

wobei c ein konstanter Anteil, den Motor betreffend, ist, und um die errechnete Induktivität mit einem Referenz-Induktivitätswert L_c zu vergleichen, für welche die Umwandlung stattfinden soll.

5. Ein Erregungssystem nach Anspruch 4, dadurch gekennzeichnet, daß der Referenz-Induktivitätswert L_c schrittweise veränderbar vorgesehen ist.

6. Ein Erregungssystem nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß die Fühler-, Rechen- und Kontrollanordnung Mittel (1) zum Anzeigen oder Errechnen der Läufergeschwindigkeit enthält,

daß die Fühler-, Rechen- und Kontrollanordnung zum Errechnen eines Wertes der Drehposition von dieser Rechnung vorgesehen ist, für welche Position die Erregung der überwachten Windung, die nachfolgend angetrieben werden soll, erfolgen soll;

daß die Fühler-, rechen- und Kontrollanordnung die Rechnung der Drehposition in dieser Position, in Abhängigkeit von dem errechneten Wert der Motor- geschwindigkeit durchführt, dargestellt durch eine positive oder negative Flanke auf einer Induktivitätskurve induktive über rotatorische Position, wie durch die Fühler-, Rechen- und Kontrollanordnung errechnet, zusammen mit Bezeichnung der Vorschrift für die Position einer Erregungs-Startzeit auf der Flanke der aktuellen Induktivitätskurve für die aktuelle Geschwindigkeit (Fig. 2).

7. Ein Erregungssystem nach Anspruch 6, dadurch gekennzeichnet, daß die Fühler-, Rechen- und Kontrollanordnung zum Darstellen der Läuferposition durch eine positive Flanke der Induktivitätskurve bei einer sehr niedrigen Motorgeschwindigkeit und durch eine positive Flanke der Induktivitätskurve bei Motorgeschwindigkeiten, die relativ nahe um 20 bis 50% der max. Motorgeschwindigkeit liegen, vorgesehen ist.

Revendications

1. Système d'alimentation pour un moteur à rélu-

tance variable, comportant :

un stator qui est muni d'un ou de plusieurs enroulements (L_1 , L_2 , L_3) pour au moins deux phases, chacune desdites phases étant une phase motrice lorsque son enroulement est alimenté,

un rotor, dont la position de rotor influence la perméance de chacun desdits enroulements de stator par coopération du rotor avec le circuit magnétique respectif desdits enroulements,

une disposition de détection, de calcul et de commande (1 à 11) détectant les propriétés électriques desdits enroulements, calculant la position de rotor en utilisant lesdites propriétés détectées et les instants de commutation de sortie d'une phase motrice et d'entrée dans une phase non-motrice, et commandant la commutation en connexion et en déconnexion desdits enroulements de phase (L_1 , L_2 , L_3) en fonction des instants calculés pour la commutation,

ladite disposition de détection, de calcul et de commande comprenant des moyens (R_1 , R_2 , R_3 , 5, 1) pour dériver l'inductance dans chaque enroulement de phase, ou une valeur qui est une approximation de l'inductance, durant au moins la partie d'un tour de rotation dudit rotor pendant laquelle l'enroulement de phase respectif est celui qui sera le suivant à être mis dans un mode moteur ;

ladite disposition de détection, de calcul et de commande comportant des moyens (R_1 , R_2 , R_3 , 5, 1) pour détecter le courant dans l'enroulement se trouvant dans un mode moteur ;

caractérisé en ce que

ladite disposition de détection et de commande comporte des moyens de calcul (1) qui calculent un facteur de correction pour ladite inductance en fonction de la valeur de courant dans l'enroulement qui se trouve dans un mode moteur.

2. Système d'alimentation selon la revendication 1, caractérisé en ce que ladite disposition de détection, de calcul et de commande corrige l'inductance de l'enroulement qui va être le prochain à se trouver dans le mode moteur en fonction du facteur de correction calculé, grâce à quoi l'inductance correspond à l'angle de rotation dudit rotor quelle que soit la valeur du courant dans l'enroulement qui se trouve dans le mode moteur.

3. Système d'alimentation selon la revendication 1 ou 2, caractérisé en ce que ladite disposition de détection, de calcul et de commande comporte des moyens (R_x , R_y) pour détecter le niveau de tension d'alimentation instantané et des moyens (1) pour corriger ladite inductance indiquée d'un facteur qui dépend du niveau de tension d'alimentation constaté.

4. Système d'alimentation selon l'une quelconque des revendications précédentes, caractérisé en ce que ladite disposition de détection, de calcul et de commande comporte des moyens (1, 2, Ta1, Ta2, Ta3) pour délivrer des impulsions de tension de

courte durée aux bornes de l'enroulement de phase dans la phase qui sera la prochaine à être alimentée et des moyens (R_1 , R_2 , R_3 , R_x , R_y , 5, 1) pour mesurer, pour chaque impulsion, le niveau de courant i_a dans ledit enroulement de phase lors de l'achèvement de l'impulsion, la durée de ladite impulsion étant de T, et pour mesurer le courant i_b dans l'enroulement de phase dans la phase alimentée et pour mesurer la tension motrice U' en conjonction avec la mesure de i_a , et pour effectuer le calcul d'inductance suivant à chaque instant de mesure :

$$L = (1 + c \cdot i_b) \cdot U' \cdot T / i_a$$

où c est une constante contingente au moteur concerné, et pour comparer l'inductance calculée avec une valeur d'inductance de référence L_c , pour laquelle la commutation se produira.

5. Système d'alimentation selon la revendication 4, caractérisé en ce que ladite valeur d'inductance de référence L_c est conçue pour changer pas à pas.

6. Système d'alimentation selon l'une quelconque des revendications précédentes, caractérisé en ce que

ladite disposition de détection, de calcul et de commande comporte des moyens (1) pour indiquer ou pour calculer la vitesse du rotor ;

ladite disposition de détection, de calcul et de commande est adaptée pour calculer une valeur de la position de rotation à partir de ce calcul, position dans laquelle l'alimentation de l'enroulement contrôlé qui sera le prochain à être moteur sera faite ;

ladite disposition de détection, de calcul et de commande est adaptée pour effectuer le calcul de la position de rotation dans cette position, en fonction de la valeur calculée de la vitesse du moteur, représentée par un front positif ou négatif sur une courbe d'inductance dans un graphique d'inductance en fonction de la position de rotation, calculée par ladite disposition de détection, de calcul et de commande, et l'indication de prescription d'une position à l'instant de démarrage d'alimentation sur le front de la courbe d'inductance effective pour la vitesse effective (Figure 2).

7. Système d'alimentation selon la revendication 6, caractérisé en ce que ladite disposition de détection, de calcul et de commande est adaptée pour représenter la position de rotor par un front positif de ladite courbe d'inductance à une vitesse de moteur très basse et par un front positif de ladite courbe d'inductance à des vitesses de moteur qui se trouvent relativement proches de 20 % à 50 % de la vitesse maximale du moteur.

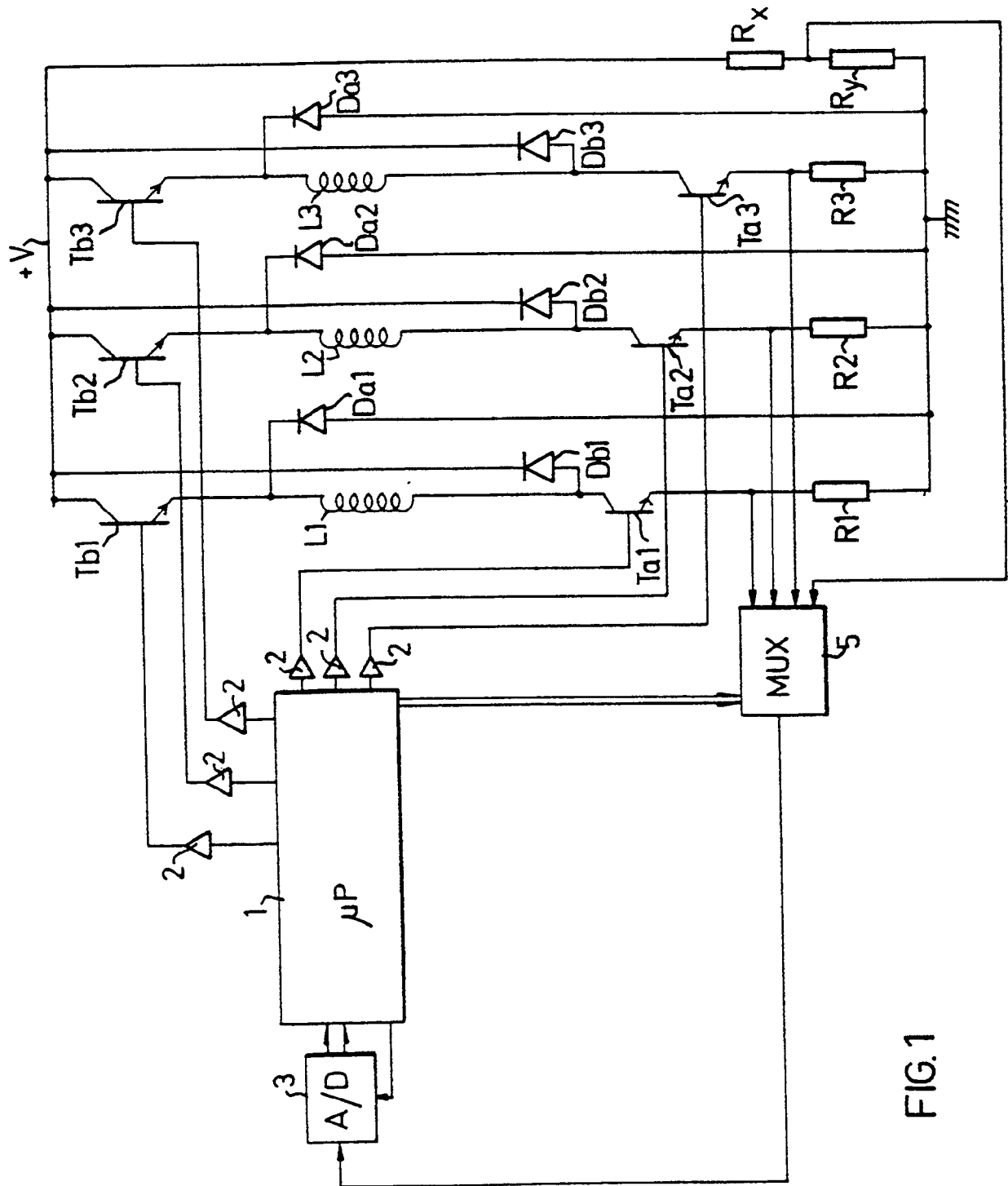


FIG. 1

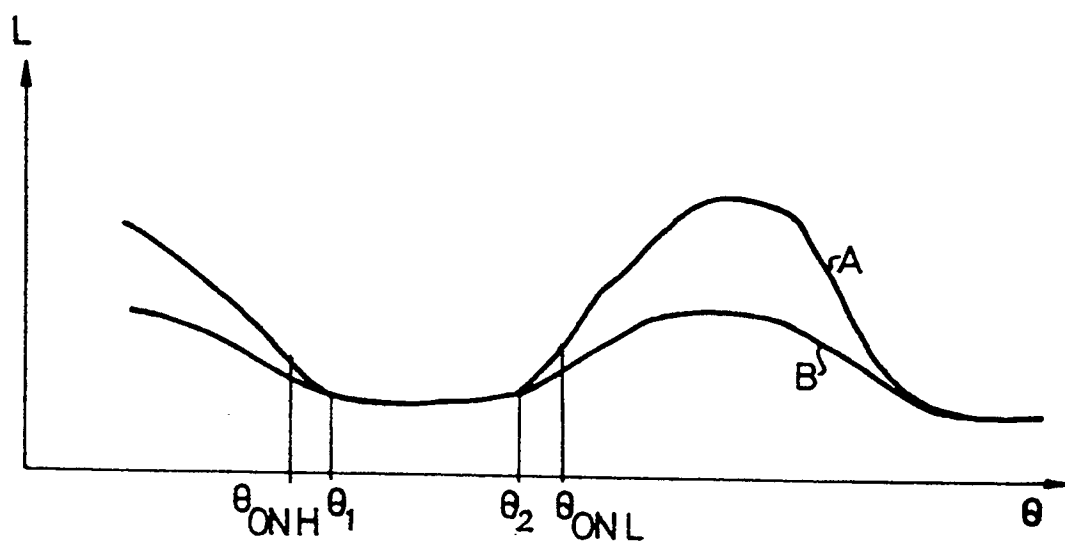


FIG.2